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Treatment of a low grade gold ore

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"Treatment of a Low Grade Gold Ore."

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SOME TESTS TO DETERMINE THE BEST METHOD OF TREATING A LOW GRADE GOLD ORE FROM THE FLAGSTAFF MINE OF OREGON.

Because of the distance from the mine it was considered impracticable to obtain a large sample of ore by freight in time to make the tests, and so all the tests were made on a small sample of ore, shipped by express.

This sample as received was crushed through a two inch ring and had a net weight of sixty-three pounds.

The method employed for sampling ore down to suitable size for analysis and tests was as follows:

First	Put all of ore through 3/4" screen.
Second	Ringed and coned twice to thoroughly mix
Third	Coned and quartered (to 31#)
Fourth	Coned and quartered again (to 15#)

One of these samples was then put through a six mesh screen, and samples of size suitable for tests cut out with a Jones Sampler and crushed through desired mesh screen, and individual test samples cut out.

A superficial examination showed the ore to consist of approximately half thoroughly fractured lumps of quartz and remainder a yellowish clay.

Ore assayed	.20 oz./ton Au.
	.16 " / " Ag.

Chemical Anlaysis was as follows:

Insoluble		62.90%
Al_2O_3 Fe_2O_3	19.8	
Silica (by fusion)	50.26	
Fe		5.28%
FeO		6.78%
Fe_2O_3		7.54%
Al_2O_3		12.26%
CaO	12.5	
Sulphur	.28	
MgO		Trace
Water ~~as~~ at 110°C for 1 hr	1.2	
" Co_2 etc.(by ignition)	14.3	
	98.14	

The remaining 1.86% might be alkaline in the clay, but as the chemical analysis was not an essential part of the work we did not feel justified in taking time from other work in order to make a complete determination

AMALGAMATION TESTS.

The object of these tests was to determine what percent of gold could be extracted by amalgamation,and how fine it was necessary to crush the ore in order to liberate the gold,and to finally treat the tailings by cyanide to see if the total extraction was increased by a previous amalgamation.

The tests were made as follows:

Samples of 500 grams of ore were crushed through 20,40,60 and 80

mesh screen respectively and mixed with water in quart fruit jars to a thick pulp. 50 grams of Mercury was added and the jars rotated for one hour at 40 revolutions per minute on a wheel 20" in diameter. Mercury was panned out and pulp dried and assayed.

Results

Test No.	1	2	3	4
Mesh Screen	30	40	60	80
% Water	40	50	60	65
Assay Tails oz/ton	.11	.12	.11	.10
% Extracted	45	40	45	50

These results show that ore could not be treated by amalgamation alone and that there is no use of crushing finer than 30 mesh for amalgamation unless subsequent cyanide treatment requires finer ore.

CYANIDE TESTS.

The object of these tests was to determine the best size of ore cor cyanide treatment, the time required for treatment, least strength of ~~revolution~~ solution and conditions which would give best extraction of gold with smallest cyanide consumption; and to determine whether previous amalgamation gave better extraction.

Standard Solutions were made up as follows:

1 Fifth Normal Hydrochloric

Strength of laboratory reagent determined with barometer, and diluted to contain $\frac{36.5}{5}$ = 5.3 gm. Hcl per litre

2 Fifth Normal NaOH solution.

Dissolve 8 gms. NaOH in one litre water and dilute till 1 cc NaOH requires 1 cc. of previous hydrochloric acid solution.

3 Standard $AgNO_3$ solution (for titration against Cyanide solution) Dissolved 6.335 gms KCN in one litre of water Using 10 c of cyanide in solution to be titrated. The c.c. of $AgNO_3$ solution required gives the pounds of KCN in one ton of solution.

4 Cyanide Solution.

Make up 1% solution by dissolving 10 gms. KCN in litre of water, and dilute this solution up as required for the weaker solutions.

This 1% solution titrated 19.7# per ton, showing that KCN used was 98.5% pure.

TESTS FOR ACIDITY.

Tests for acidity were made in order to determine whether it was necessary to take measures for its removal to prevent cyanide consumption.

1 Soluble Acidity.

Agitated 10 grams ore with pure distilled water for 20 minutes, filtered and tested for acidity.

Result. No soluble Acidity.

2 Latent Acidity.

Agitated 10 grams ore with MgO and 20 cc n/5 NaOH for twenty minutes, filtered and washed thoroughly. Required 18 cc n/5 HCl to neutralize.

Result: 10 grams ore required 2 cc. NaOH.

Confirmed above results by agitating at intervals for 48 hours 100 grams ore with 200 c.c. water containing 20 c.c. n/5 NaOH solution.

Result 10 c.c. sol. before took 1 c.c. n/5 HCL
10 " " " after " 1/3 " " "

Acidity required 17 1/3 c.c. n/5 NaOH per 100 gms. of ore, or
1 ton ore requires 3.2# NaOH
1 " " " 2.2" CaO.

AGITATION TESTS WITH CYANIDE SOLUTION.

Tests were made as follows:

Placed 100 gms ore in quart fruit jars with 200 c.c. cyanide solution containing 20 c.c. n/5 NaOH and agitated by revolving at 30 R.P.M. on wheel 20" in daimeter.

The object of the experiment was to determine whether cyanide would give satisfactory extraction on raw ore and to what size ore must be crushed, also whether neutralization of acid diminished consumption of ~~test strength of acid~~ cyanide.

The following is a table of the results

Test	1	2	3	4	5	6	7	8	9	10	11	12
Mesh	20	40	60	80	20	40	60	80	20	6	20	20
Time Agitated in hrs.	24	24	24	24	48	48	48	48	48	48	48	48
Lbs.KCN. / Ton.Sol. Before	4.48	4.48	4.48	4.48	4.48	4.48	4.48	4.48	4.48	4.48	8.96	8.24
Lbs.KCN. / Ton.Sol. After	Exposed to air before titration				4.07	4.16	4.07	4.11	3.50	4.14	8.59	1.90
Consumption lbs/ton used					.41	.32	.41	.37	.98	.34	.34	.34
Lbs.NaOH / Ton.Sol. Before	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	none	1.6	1.6	1.6
Lbs.NaOH / Ton.Sol. After #	slightly alkaline				...	.....			acid	slightly alkline		
Assay of Tails Oz/ton.	.06	.04	.03	.02	.025	.02	.02	.035	.02	.025	.04	.02
% Extraction	70	80	85	90	87 1/2	90	90	82 1/2	90	87 1/2	80	90

\#

Tested for alkali after titrating for cyanide after adding slight excess of $AgNO_3$

Above results show that by treating 48 hours, 20 mesh or even 6 mesh (only one test) gave as good extraction as finer ore. Test #9 shows that neutralizing acid decreases cyanide consumption but does not change extraction and test 12 gives as good extraction with 1/8 percent solution as other tests with 1/4 percent solution.

PERCOLATION TESTS.

These tests were made in a rough way to give best extraction by percolation, and to see if previous amalgamation increased extraction.

Twelve tests were made on six mesh ore for 2,4,6,8, and 10 days respectively, and five on 20 mesh ore for same period, the other two being 20 mesh amalgamation tests for amalgamation test No.1.

200 grams of ore was treated on filter paper in 3" funnel closed at bottom with rubber hose and stop cock. Fresh solution was added every day, allowed to stand twenty-four hours and then drained off and new solution added. Added 150 c.c. first day and 100 c.c. every day afterward.

Results of tests is shown in the following table:

Test.	mesh	Time days	Tails oz/ton	% Extraction.
# 1	6	2	.06	70
2	6	4	.03	85
3	6	6	.045	77 1/2
4	6	8	.045	77 1/2
5	6	10	.035	82 1/2
6	20 amal.tails #	5	.04	80 total
7	20 " " "	10	.02	90 total
8	20	2	.075	62 1/2
9	20	4	.04	80
10	20	6	.03	85
11	20	8	.02	90
12	20	10	.02	90

No date was taken on cyanide consumption because of great exposure to air.

It was impossible to get any data in regard to cyanide consumption in these tests because of the large evaporation due to porous filter paper extending out of liquid, and on the whole was a poor method of making tests.

These tests show a somewhat better extraction on 20 mesh than on 6 mesh by treating a long time, but not enough better to pay for additional crushing and longer treatment and as the ore is one which is liable to cause trouble by sliming in treatment on practical scale it would be best to treat it as course as possible.

Preliminary amalgamation gives no better extraction than by treating ore direct with cyanide so is unnecessary.

From results of the above tests we decided to make two final tests, one on 6 mesh ore and one on 20 mesh ore.

The remainder of ore (through 6 mesh) was mixed thoroughly and cut in half with Jones Sampler, and one half crushed through 20 mesh. Finished sample contained 13 3/4# and six mesh ~~17 5/4~~ 14 3/4

A percolation apparatus was made as follows:

Obtained two glass bell jars 7" in diameter and 18" high. Made filter by sawing out circles from 1/2" board so that when the board was full of holes and canvas stretched over them they ~~filter-~~ fitted ed tightly within about 3" from neck of jar.

14 3/4# of 6 mesh ore was placed in one jar and 13 3/4# of ~~8~~ 20 mesh ore in the other, after mixing each with 10 grams CaO a slight excess over calculated amount required.

Bottom of jars were closed with one hole rubber cork, with glass rod and rubber hose leading up to funnel.

The first solution of 3# strength was added from the bottom by pouring into funnel and keeping funnel elevated a little above level of ore.

After solution had covered the ore which required about 1/2 hour, it was allowed to stand and soak 24 hours. Ore was then drained off and some solution poured in from top and allowed to percolate 24 hours, and was then drawn off, titrated and samples taken for assay.

For the remainder of the five days of the treatment the ore was covered every day with a freshly prepared #2 cyanide solution, allowed to percolate 24 hours and then drawn off, titrated and sampled for assay as above.

On the fifth day the ore was allowed to drain out thoroughly and was washed by covering with water and allowing to drain out three times.

Tailings were dried and assayed.

Table of Results.

Day of Test.		1st	2nd	3rd	4th	5th	6th
Solution Added	Vol.in c.c.	5000 from bottom	same sol from top	2000	1,000	1,000	
	(Lbs.KCN/ton used	3.	2.1	2.	2.	2.	
Solution Drawn off	Vol in c.c.		pounded back	1975	1875	975	980
	lbs.KCN/ton sol.		2.1	1.2	1.2	1.2	1.2
	Au. oz/ton sol.			.238	.106	.052	.04
	Total Mgms Au.			21.23	6.63	1.69	1.47
	% of total Au (44.7 mgms)			47.4	15	4	3.

Total Extraction 74%

Tails assayed .055 oz/ton.

Test on 20 Mesh. Total extraction only 30%

Treated in same manner as above, but did not percolate nearly so well, and toward last of treatment the ore packed so that it was almost impossible to pass solution through it.

Conclusion.

This last test on 20 mesh ore shows that the ore cannot be treated by percolation as fine as 20 mesh unless slimes are separated and treated separately.

The 6 mesh ore percolated very readily and I believe this size ore could be treated on a larger scale by percolation without trouble from slimes, and should be able to get about 75% extraction.

It is possible that ore might be treated with good extraction still coarser than 6 mesh and of course the coarser the ore the better it will percolate without interference from slimes.

75% extraction is about the best you could expect to obtain by single percolation and ore is too low grade to pay for separation and agitation of slimes

Would advise beginning treatment by a five day percolation on 6 mesh ore and a 3# cyanide solution, and determine in the plant how much coarser it could be treated without lowering extraction and also how much weaker solution could be used without lowering extraction.